



## Evaluating the Integration of Architectural Solutions such as Multi-Angled Facades in Specific Urban Contexts

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# **EVALUATING THE INTEGRATION OF ARCHITECTURAL SOLUTIONS SUCH AS MULTI-ANGLED FACADES IN SPECIFIC URBAN CONTEXTS**

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## **INTRODUCTION**

The aim of this paper is to structure and qualify discussions about, and architectural evaluations of, the use of multi-angled façades in given urban contexts and whether they architecturally improve the local environment. This is combined with a short presentation of the sustainable potential of this façade system in a holistic perspective. An interview regarding the design concept of an office building in Copenhagen that has a multi-angled facade is presented in this research paper.

The context regarding urban architecture is the surrounding environment and its various constructions – physical, social, economic, ecological, cultural and so on. Architects are expected to weave their original and renovation work into this context in an integrated way.<sup>1</sup> This research paper concentrates on this process of weaving.

The multi-angled façade system concept described in this research paper proposes the use of two different orientations of windows in each façade to optimize the availability of solar radiation and daylight through the façades.

All the technical investigations and calculations concerning the multi-angled facade systems were presented in a prior research paper (*Multi-angled facade system for office building renovation*)<sup>2</sup> by the authors of this research paper. This paper will recap on some of the main technical data and potential benefits.

## **BACKGROUND**

After the Second World War, a higher degree of industrialization was necessary in Denmark to meet the expected expansion in all sectors of society, both public and private.<sup>3</sup> As a result, a large number of office buildings built between 1960 and 1980 in Denmark are facing problems regarding high energy consumption, poor indoor climate and problems with durability.<sup>4</sup> Most of the problems that face these office buildings are related to the external envelope, while the internal part of the building has shown good durability<sup>5</sup>. As the same type of modernist architecture were built in many western countries, it is likely to expect that the problems described have occurred not only in a Danish context.

The building's facade gives the building its face. Here, the form, materials and proportions meet the technical essentials such as insulation, ventilation, lighting and noise.<sup>6</sup> Façade renovation calls for sustainable solutions that need to be investigated and optimized, both technically and architecturally. Regarding the architectural optimization, there is a need to focus also on architecture's urban context: place, path and people. Regarding place, this can refer to the surrounding buildings, including their façades, functions, size and expression. In this perspective, the relation between the newly renovated building and other surrounding buildings is investigated.

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## METHOD

A review of the available literature has been performed to investigate the advantages and potential applications of multi-angled façade systems. A qualitative research/ phenomenological method is applied to provide deeper understanding of the implications of implementing this façade system on existing buildings. The study also uses a simulation research method to visualise office buildings renovated with a multi-angled façade system, using the software packages AutoCAD, 3D Max and Photoshop. The simulation has been performed in two specific urban contexts, both in Copenhagen.

## THE CONCEPT OF MULTI-ANGLED FAÇADE SYSTEMS

The concept of a multi-angled window is based on proposing the use of two different orientations of windows in each façade on a vertical axis (right and left), but not tilted up and down. The large part of the multi-angled façade is oriented more to the north and the small part of the multi-angled façade more to the south. This configuration will help to minimize the use of solar radiation and optimize daylight through the façades.

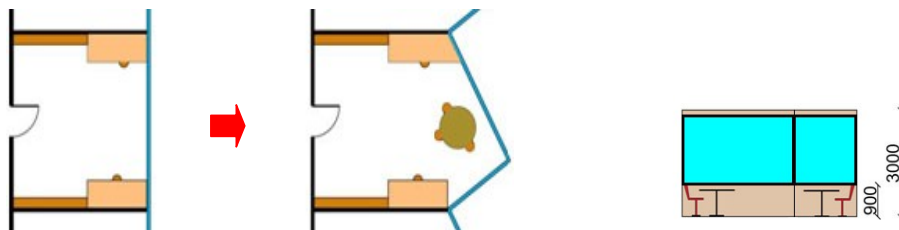


Figure 1: (left) Changing the configuration from a flat façade into a multi-angled façade when renovating it. (Right) internal view of a multi-angled façade.

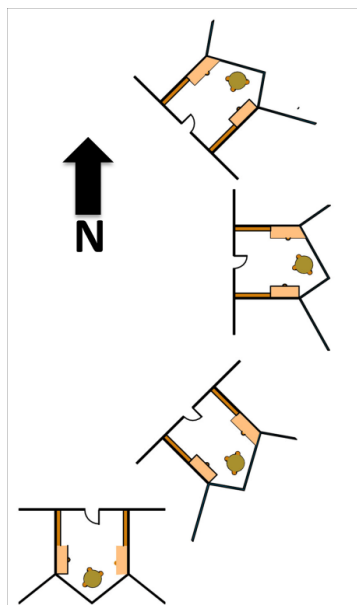


Figure 2: Different orientations for an office room, where the large window is oriented more to the north and the small window more to the south

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## THE POTENTIAL OF MULTI-ANGLED FAÇADE SYSTEMS

Different scenarios were previously simulated for an office room, and the results showed that there is a potential saving in primary energy consumption when renovating with a multi-angled façade system (especially for lighting and heating). The difference in total primary energy consumption between renovating with an energy-efficient flat façade and a multi-angled façade varies between 4.9 and 6.5 kWh/(m<sup>2</sup>.year), depending on the orientation of the façade.<sup>2</sup>

The multi-angled façade provides more daylight to the office room, which has better rendering, leading to improved optical quality and a positive impact on indoor climate. The optimized daylight is of great importance to physical and mental well-being; it regulates daily rhythm and can help relieve stress and depression. In addition to that, daylight and passive solar heat are free resources that can be utilized inside the building<sup>7</sup>. A very big advantage may be that, while having the solar shading shut on one part of the room façade due to direct solar radiation, another part of the façade may have no shading, thus continuing to provide daylight and views to the outside on sunny days.

On the other hand, there are some disadvantages using this façade system, including that the cost is much higher than using a flat facade. In addition to that, there are some structural, construction and architectural limitations for using this façade system as a renovation strategy, such as if the old parapet is made of heavy construction materials, or regarding the placement of old beams in the façade, and also the distance between the façade and the pavement.

## THE USE OF MULTI-ANGLED FAÇADES IN GIVEN URBAN CONTEXTS: EVALUATION AND DISCUSSION

The evaluation of multi-angled façades has been achieved in two ways. The first method was by studying a real case of a building in Denmark through interviews with the designer and with the users of the building. The second method was through a virtual simulation of the post-renovation façades of office buildings built between 1960 and 1980.

### Discussing the use of multi-angled façades in real projects in Denmark

#### *Horten Headquarters designed by 3XN*

An interview was carried out with architect Olaf Kunert from architectural firm 3XN, who was one of the main members of the design team for the Horten building. Kunert mentioned that there was a focus, when designing the Danish Law Firm Horten's new head office, on the quality of the surrounding area. There was a canal to the north and office buildings on other sides, and the most attractive orientation was to the north. By directing the building to this orientation, it was also possible to block the sun from the south and minimize the duration for which the shading devices are closed for the rest of the building.<sup>8</sup> The designer tried to create a visual and optical quality for the people inside the office building and improve the indoor thermal climate.

There was a focus on the correct choice of cladding materials for the building. The designers believed that using natural stone sourced from Italy with a beige colour could create an expression of trust,<sup>9</sup> and thus succeeded in creating an expression that suits the function of the company.

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Figure 3: Horten Headquarters designed by 3XN, Hellerup, Denmark  
Source: 3XN website, <http://www.3xn.com>.<sup>13</sup>

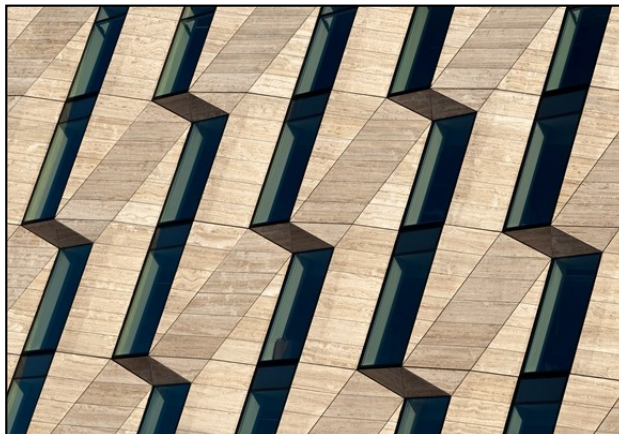


Figure 4: The pattern of the façade which is based on the repetition of more than one element  
Source: 3XN website, <http://www.3xn.com>.<sup>14</sup>

An interesting characteristic of this building façade is that when viewers come from the south they will only see a stone façade, and when they approach from the north they will see only glass, while from the east and west they will see a pattern combining glass and stone.<sup>10</sup> This sudden change in the façade when moving around it gives a feeling of interest to the viewers.

The designers tried to create a pattern based on the repetition of more than one element, thus creating a dynamic form for the façade which was mirrored in the façade on the other side of the building.<sup>11</sup> However, the designers also attempted to avoid creating an expression that might be boring if repeating one element only in a simple way.

On the other side of the canal there is a shopping centre where people can sit and enjoy the view across to the Horten office building, so the appearance of the façade is important for the street and the viewers on the other side of the canal.<sup>12</sup> This reflects the impact of the façade design on the people working or shopping in the surrounding areas.

A short interview was conducted with Kjeld Rask, an employee working in the Horten building, and he understands that it is a brand new building where daylight and indoor climate are much different compared to the old building they were working in. The room window is large and oriented more to the north without a shading device, so there is a lot of daylight in the working area. There is a nice view from the office room to the harbour, which Kjeld Rask appreciates. Local people tell Kjeld that the Horten building is the most prestigious in the area and there is a lot of respect for it<sup>15</sup>. As this example shows, there are great architectural as well as indoor climatic potentials of working with multi-angled facades.

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### Virtual simulation of the façades of office buildings built between 1960 and 1980 following their renovation

Two cases of office buildings built between 1960 and 1980 are simulated virtually to evaluate the architectural impact of renovating them with multi-angled façades to surrounding buildings in different urban contexts. The architectural evaluation is based upon a number of the main constituents of architecture: form, style, rhythm, transparency, colour and texture of both the multi-angled facade and the urban context.

- The form refers to different visual properties such as shape, size, color and texture.<sup>16</sup>
- The proportions of a facade can be due to the nature of materials, structure system, function or manufacturing process.<sup>17</sup>
- Ordering principles such as:<sup>18</sup>
  - Rhythm/ repetition, which refers to the use of recurring patterns and their resultant rhythms;
  - Symmetry, which refers to the balanced distribution of equivalent forms and spaces about a common line (axis).
- Transparency – focuses more on the two types of transparency; perceptual transparency is a quality inherent to substance or matter, such as translucent walls, etc.; and conceptual transparency, a quality inherent in the spatial or volumetric organization.<sup>19</sup>
- Style – this varies with the character of culture in different places and at different times, forming distinct modes of languages of expression, such as classicism or modernism, etc.<sup>20</sup>

#### ***An office building attached to a traditional building.***

The neighbouring building attached to the newly renovated office building has a traditional style. Concerning the form, the multi-angled facade has a more dynamic form and the proportion of the windows to the parapets of the renovated building is very different from the small window units in the traditional building. The size of the whole renovated building is much larger than the traditional building. Concerning the style, the neighbouring building has a traditional style with arched windows and with symmetry around a central vertical axis of the front facade, while the renovated facade has a modern style and sharply angled facade units. Concerning the rhythm, the repetition of the facade units can create a kind of a rhythm, which is very different from the rigid symmetric facade and the rhythm it might express. Concerning transparency, the new facade elements are much more transparent than the traditional building with its large area of solid walls.

Concerning colour and texture, the traditional building has a sharp red colour which is different from the brown colour (not sharp but a little dark) of the renovated façade, as shown in Figure 7, and also different from the gray coloured façade (not sharp but light), as shown in Figure 8, but somehow, the brown colour works better than the grey colour. There is no texture in the red painted wall of the traditional façade, while the cladding materials (fibre cement plates) might have a texture or a pattern on them.

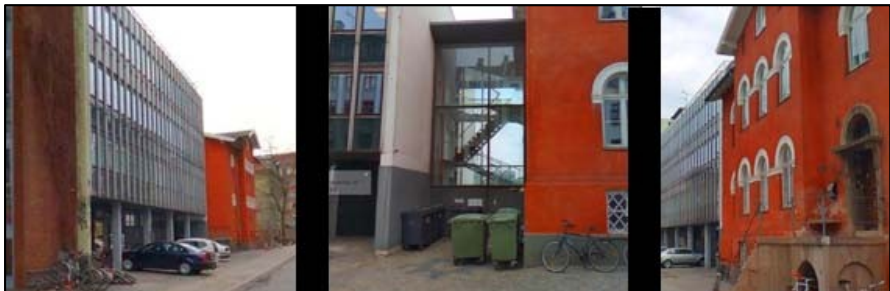


Figure 5: Three perspectives of the office building attached to a traditional building before the virtual simulation



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*Figure 6: A perspective of the office building attached to a traditional building before the virtual simulation*



*Figure 7: A perspective of the attached office building after the virtual simulation with brown cladding material*



*Figure 8: A perspective of the attached office building after the virtual simulation with light colored cladding material*

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### ***An office building attached to a modern building.***

The renovated office building with a multi-angled façade is attached to a building with a modern style. Concerning the form, the renovated building has a more dynamic form. There is also similarity regarding the height of the two buildings and the continuity of parallel rows (windows and parapets) between the two buildings. The proportions of the façade elements (between windows and parapets) are almost the same between the two buildings. Concerning the style, both of the buildings have a modern style. Concerning transparency, this is high for both buildings. Concerning rhythm, it is deeper in the renovated façade while it is simpler in the neighboring façade (horizontal lines only).

Concerning colour and texture, it is possible to create a similarity between the cladding materials of the two buildings. In the case of using different colours on both sides of the multi-angled units, the expression will be sharper and the difference will increase with the neighbouring building, as shown in Figure 11. In spite of that, the similarity between the two buildings concerning form, size and the proportions helps the two buildings to have an accepted attachment to each other



*Figure 9: The office building attached to a modern building before the virtual simulation*



*Figure 10: A perspective of the attached office building after the virtual simulation. The same cladding materials are used on both sides of the multi-angle units*



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*Figure 11: A perspective for the attached office building after the virtual simulation. Two different types of cladding materials are used on both sides of the multi-angle units*

## DISCUSSION

The configuration of multi-angled units can provide an interesting façade with a dynamic external form in some cases, or it might give a noisy expression in other cases. Different façade cladding concepts are possible, such as the use of contrast and harmony between the two-façade parts through appropriate selection of materials and colours.

Different parameters can affect the acceptance of the renovated building in an urban context and its relation to the surrounding buildings, for example, whether it is physically detached or attached, and the size, form, style, rhythm, transparency, colour and texture, and other properties. When the renovated building is attached to other buildings, careful decisions need to be made regarding the chosen materials to create a visual match with surrounding buildings in the urban context. Having the renovated building attached to a traditional building might create a profound contrast between both buildings' façade designs. The renovated building might dominate the traditional building, and the latter might have an interesting style that needs to be preserved and perhaps only expressed without disturbance from other, different styles. In this case, the concept of using a multi-angled facade might not be suitable. It is possible to create visual matching between the two buildings by using suitable colours and if the size of the facades is similar, an accepted attachment might be achieved between the two buildings. In the case of there being no dominance and where there are similarities between the two buildings regarding size or shape, a careful choice of cladding materials can be made to create harmony or visual matching between the two building expressions. Having the renovated building detached from the surrounding buildings gives more freedom in the design of the new façade's dimensions, colour and texture. In this regard, it is important to mention that consideration of cladding materials should not focus only on their appearance, but also on other aspects such as durability, mould resistance and should also consider fire resistance, -as demonstrated by the disastrous recent fire at Grenfell Tower in London.

## CONCLUSION

The multi-angled façade has considerable technical potential, especially optical and visual. In addition to that, the configuration of the multi-angled façade might also be interesting and dynamic. Having the building detached or attached to neighbouring buildings can have an influence on the freedom of the designer when selecting the cladding materials and deciding their colour, texture and other properties. The choice of cladding materials is important in order to create a kind of harmony between the renovated and the neighbouring buildings without being significantly different or in contrast. Having the renovated building attached to a building with a modern style helps the renovated building to be

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better accepted in an urban context, when compared to attachment to a traditional building, which might create some problems concerning the traditional style.

## NOTES

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